REMARKS

This is in response to the Office Action that was mailed on February 22, 2006. Claims 1 and 9 are amended to specify that the resin constituting the wall of the microcapsule in this invention is an anionic resin, in accordance with such disclosure in the specification as that in lines 20-25 on page 12 and from line 21 on page 14 through line1 on page 15. Claims 1, 2, 4-10, and 12-15 remain pending in the application.

Honeyman

Claims 1, 2, 4-10, and 12-15 were rejected under 35 USC § 102(e) as being anticipated by US 6,822,782 B2 to Honeyman et al. (Honeyman). The rejection is respectfully traversed.

The Honeyman reference discloses not only an electrophoretic medium comprising pigment particles suspended in a fluid and a polymer chemically bonded to or cross-linked around the particles but also capsules encapsulating the pigment particles and the fluid as follows (emphasis supplied):

In claim 1: "1. An electrophoretic medium comprising a plurality of pigment particles suspended in a suspending fluid, the pigment particles having from about 1 to about 15 percent by weight of the pigment of a polymer chemically bonded to, or cross-linked around, the pigment particles."

In claim 2: "2. An electrophoretic medium according to claim 1 wherein the polymer is cross-linked around the pigment particles."

In claim 23: "23. An electrophoretic medium according to claim 1 wherein the pigment particles and the fluid are encapsulated in a plurality of capsules."

In claim 68: "68. A two-phase electrophoretic medium comprising a continuous phase and a discontinuous phase, the continuous phase comprising at least about 40 percent by volume of the electrophoretic medium, the discontinuous phase comprising a plurality of droplets, each of which comprises a suspending fluid and at least one pigment particle disposed within the suspending fluid and capable of moving through the fluid upon application of an electric field to the electrophoretic medium, the continuous phase surrounding and encapsulating the

discontinuous phase, the pigment particle comprising a polymer chemically bonded to, or cross-linked around, the pigment particle."

Furthermore, the following teachings are also found in the Honeyman reference (emphasis supplied):

Column 5, line 60 to column 6, line 31

In one aspect, this invention provides an electrophoretic medium comprising a plurality of pigment particles suspended in a suspending fluid, the pigment particles having from about 1 to about 15 percent by weight of the pigment of a polymer chemically bonded to, or cross-linked around, the pigment particles. This aspect of the invention may hereinafter be referred to as a "controlled polymer electrophoretic medium" of the invention.

In another aspect, this invention provides an electrophoretic medium comprising a plurality of carbon black particles suspended in a suspending fluid, the particles having from about 1 to about 25 percent by weight of the carbon black of a polymer chemically bonded to, or cross-linked around, the carbon black particles. This aspect of the invention may hereinafter be referred to as a "controlled polymer carbon black electrophoretic medium" of the invention.

In another aspect, this invention provides an electrophoretic medium comprising a plurality of pigment particles suspended in a suspending fluid, the pigment particles having a polymer chemically bonded to, or cross-linked around, the pigment particles, the polymer comprising a main chain and a plurality of side chains extending from the main chain, each of the side chains comprising at least about four carbon atoms. This aspect of the invention may hereinafter be referred to as a "branched chain polymer electrophoretic medium" of the invention.

In another aspect, this invention provides a two-phase electrophoretic medium comprising a continuous phase and a discontinuous phase, the discontinuous phase comprising a plurality of droplets, each of which comprises a suspending fluid and at least one pigment particle disposed within the suspending fluid and capable of moving through the fluid upon application of an electric field to the electrophoretic medium, the continuous phase surrounding and encapsulating the discontinuous phase, the pigment particle comprising a polymer chemically bonded to, or cross-linked around, the pigment particle. This aspect of the invention may hereinafter be referred to as a "polymer dispersed electrophoretic medium" of the invention.

Column 12, lines 47-61

Gelatin forms a film by a sol/gel transformation, but the present invention is not restricted to film-forming materials which form their films by such sol/gel transformation. For example, the formation of the film may be accomplished by the polymerization of a monomer or oligomer, by the cross-linking of a polymer or oligomer, by radiation-curing of a polymer or by any other known film-forming process. Similarly, in the preferred variant of the invention in which the film is first formed and then caused to shrink in thickness, this shrinkage need not accomplished by the same type of dehydration mechanism by which a gelatin film shrinks, but may be accomplished by removal of a solvent, aqueous or non-aqueous, from the film, cross-linking of a polymeric film or any other conventional procedure.

Column 20, lines 44 to Column 21, line 17

The polymerizable and initiating groups used in the present processes may be any of those known in the art, provided of course that the relevant groups are compatible with the reactions used to attach them to the particle surface. The present invention extends to processes in which the polymerizable or initiating group is subject to chemical modification, for example by removal of a protecting group, after it has been attached to the particle surface. If, for example, a particular polymerization required the presence of a carboxylic acid group on the particle surface, the bifunctional reagent used might contain this group in esterified form, with the group being de-esterified after it has been attached to the particle surface. (A similar procedure may be employed when preparing a surface for ionic bonding to a polymerizable group in the ionic RGP process of the present invention. For example, a silica/alumina coated titania particle may be treated with a copolymer of 3-(trimethoxysilyl)propyl methacrylate and t-butyl acrylate, thus causing the silyl groups to bond to the particle surface, and leaving the esterified acrylate groups exposed. The particle is then treated with acetic acid to convert the esterified acrylate groups to free acrylic acid groups. Subsequent reaction of the particle with dimethylaminoethyl methacrylate causes an acid/base reaction and ionically bonds the methacrylate groups to the particle, where they serve as polymerizable groups for use in an RGP process.) Similarly, when it is desired to attached a chloroalkyl group to the particle surface to serve as an initiator for ATRP, the bifunctional reagent used might contain the corresponding

hydroxyalkyl group, which could be converted to the desired chloroalkyl group by reaction with a chlorinating agent, for example thionyl chloride.

The preferred polymerizable groups for use in the present processes are ethylenically unsaturated groups, especially vinyl, acrylate and methacrylate groups. The preferred initiating groups for ATRP are haloalkyl groups, desirably chloroalkyl groups and most desirably chloromethyl groups. Free radical polymerization initiating groups which may be used include those derived from [10-(t-butyidioxy)decyl] bromide, 2-(carbamoylazo)isobutyronitrile, and 4,4'-azobis(4-cyanovaleric acid).

Column 23, line 66 to Column 25, line 3

It is preferred that the polymers formed on particles by the present processes include charged or chargeable groups, since such groups are useful in controlling the charge on the electrophoretic particles. Hitherto, the charge on electrophoretic particles has normally been controlled by adding to the electrophoretic medium a charge control agent, which is typically a surfactant which absorbs on to the particles and varies the charge thereon. --- In the case of an encapsulated dual particle electrophoretic medium, it is also possible for the charge control agent to adsorb on to the capsule wall. Providing charged groups within the bound polymer ensures that these charged groups remain fixed on to the particle, with essentially no tendency to desorb (unless the polymer chains themselves are rendered capable of desorption, as already discussed).

Instead of incorporating charged or chargeable groups within the polymer attached to the pigment particle, or in addition thereto, charged or chargeable groups may be directly to the pigment particle without being incorporated into a polymer, although in most cases it will be desirable to provide polymer on the particles surface in addition to the charged or chargeable groups.

Charged or chargeable groups may be incorporated into the polymer via either the bifunctional agent used to provide polymerizable or initiating functionality to the pigment, or via one or more monomers used to form the polymer chain. --- On the other hand, if the charged or chargeable groups are to provided via monomers, a variety of acrylates and methacrylates are available containing acidic or basic groups, as are a variety of other monomers (for example, 4-vinylpyridine) containing a polymerizable group and a basic or acidic group. As previously mentioned in other contexts, it may be desirable to provide the acidic or basic group in a

"blocked" form in the monomer used, and to de-block the group after formation of the polymer. For example, since ATRP cannot be initiated in the presence of acid, if it is desired to provide acidic groups within the polymer, esters such as t-butyl acrylate or isobornyl methacrylate may be used, and the residues of these monomers within the final polymer hydrolyzed to provide acrylic or methacrylic acid residues.

Column 26, line 26 to Column 27, 18

A. Suspending Fluid

--- A preferred suspending fluid has a low dielectric constant (about 2), high volume resistivity (about 10.sup.15 ohm-cm), low viscosity (less than 5 centistokes ("cst")), low toxicity and environmental impact, low water solubility (less than 10 parts per million ("ppm")), high specific gravity (greater than 1.5), a high boiling point (greater than 90.degree. C.), and a low refractive index (less than 1.2).

--- Organic solvents, such as halogenated organic solvents, saturated linear or branched hydrocarbons, ---

Useful hydrocarbons include, ---, dodecane, tetradecane, the aliphatic hydrocarbons in the Isopar ---, Norpar ---, Shell-Sol ---, and Sol-Trol ---. --- Useful examples of silicone oils include, ---, octamethyl cyclosiloxane and higher molecular weight cyclic siloxanes, ---.

Column 29, line 52 to Column 30, line 25

C. Encapsulation

Encapsulation of the internal phase may be accomplished in a number of different ways. Numerous suitable procedures for microencapsulation are detailed in both Microencapsulation, Processes and Applications, --- and Gutcho, Microcapsules and Microencapsulation Techniques, ---. The processes fall into several general categories, all of which can be applied to the present invention: interfacial polymerization, in situ polymerization, physical processes, such as coextrusion and other phase separation processes, in-liquid curing, and simple/complex coacervation.

Numerous materials and processes should prove useful in formulating displays of the present invention. Useful materials for simple coacervation processes to form the capsule include, ---, gelatin, poly(vinyl alcohol), poly(vinyl acetate), and cellulosic derivatives, ---. Useful materials for complex coacervation processes include, ---, gelatin, ---. Useful materials

for phase separation processes include, ---, polystyrene, poly(methyl methacrylate) (PMMA), poly(ethyl methacrylate), poly(butyl methacrylate), ethyl cellulose, poly(vinylpyridine), and polyacrylonitrile. Useful materials for in situ polymerization processes include, ---, polyhydroxyamides, with aldehydes, melamine, or urea and formaldehyde; ---. Finally, useful materials for interfacial polymerization processes include, ---, diacyl chlorides, --- and di- or poly-amines or alcohols, and isocyanates. Useful emulsion polymerization materials may include, ---, styrene, vinyl acetate, acrylic acid, butyl acrylate, t-butyl acrylate, methyl methacrylate, and butyl methacrylate.

Column 30, lines 58-65

An encapsulation technique that is suited to the present invention involves a polymerization between urea and formaldehyde in an aqueous phase of an oil/water emulsion in the presence of a negatively charged, carboxyl-substituted, linear hydrocarbon polyelectrolyte material. The resulting capsule wall is a urea/formaldehyde copolymer, which discretely encloses the internal phase. The capsule is clear, mechanically strong, and has good resistivity properties.

Comparison of the claimed subject matter with the Honeyman disclosure:

Honeyman fails to disclose or suggest not only anionic resins having an acid group or a salt thereof but also a wall formed by crosslinked or cured anionic resins. Thus, the presently claimed subject matter would is not motivated by Honeyman.

In more detail, Honeyman disclose the polymer cross-linking around the pigment particles, comprising charged or chargeable groups, or amino or carboxylic acid groups (see e.g. Honeyman claims 2-4). However, it should be noted that these polymers do not comprise the wall of capsules. Instead, they are chemically bonded to, or cross-linked around, the particles. This is apparent from the fact that polymerizable and initiating groups are used for attaching these groups to the particle surface (see column 20, line 44 to column 21, line 17) and that polymerization between urea and formaldehyde is used for an encapsulation technique, resulting in a capsule wall of a urea/formaldehyde copolymer (see Section "C. Encapsulation" and column 30, lines 58-65). Therefore, the combination of all of elements of the presently claimed subject matter is simply not found in the Honeyman reference.

Whitesides

Claims 1, 2, 4-10, and 12-15 were rejected under 35 USC § 102(e) as being anticipated by US 2005/0168799 A1 to Whitesides et al. (Whitesides). The rejection is respectfully traversed.

The content of the Whitesides reference is similar to that of the Honeyman reference. Whitesides discloses as follows.

In claim 1: "1. An electrophoretic medium comprising an electrically charged particle suspended in a suspending fluid, the particle having a polymeric shell having repeating units derived from at least one monomer the homopolymer of which is incompatible with the suspending fluid."

In claim 2: "2. An electrophoretic medium according to claim 1 wherein the polymeric shell further comprises repeating units derived from at least one monomer the homopolymer of which is compatible with the suspending fluid."

The combination of all of elements of the presently claimed subject matter is not found in the Whitesides reference.

Unexpected advantages

As explained above, the Examiner has failed to establish a prima facie case of obviousness based upon either the Honeyman or the Whitesides reference. In any case, however, the present invention provides unexpected advantages.

The references require, for obtaining a microcapsule, plural steps such as a step for reacting pigment particles with a reagent to attach the polymerizable group thereto, a step for reacting the resultant particles with at least one monomer or oligomer to form a polymer (or polymer-coated particles), in which the polymer is chemically bonded to or cross-linked around the pigment particles, a step for preparing an internal phase comprising the pigment particles and the fluid by dispersing the polymer-coated particles into the fluid, and a step for encapsulating the internal phase by use of polymer-formable technique including polymerization between urea and formaldehyde.

Thus, in the reference technologies, the disperse system comprising polymer-coated pigment particles and the fluid cannot be transformed efficiently into capsules while controlling

the particle size of the capsules with a sharp size distribution. Furthermore, the references fail to form microcapsules having a sharp and uniform particle size while at the same time inhibiting the formation of non-capsule particles, since the references encapsulate the disperse system by conventional techniques. This is apparent from the fact that capsules in the Examples, e.g. of the Honeyman reference, have a large size and a wider size distribution (see Example 7, column 37, lines 41-49; Examples 8-12, Column 38, lines 38-40; Example 29, Column 48, lines 11-19; Example 30, Column 49, lines 50-57), although Honeywell alleges that "The capsules may have diameters in the millimeter range or the micron range, but are preferably from about ten to about a few hundred microns" (column 33, lines 46-50).

In contrast, since the present invention utilizes anionic resins which are useful to form the cross-linked or cured wall of capsules by phase inversion emulsification, the particle size of microcapsules can be controlled precisely in the present invention, while inhibiting the formation of non-capsule particles. Therefore, a sharp and uniform size distribution of microcapsules can be realized independent of a dispersiveness of a core material. These unexpected benefits of the present invention are established by data in Applicants' Examples.

In view of the above amendments and remarks, Applicants believe that the pending application is in condition for allowance.

If there are any questions concerning this application, please contact Applicants' representative, Richard Gallagher (Reg. No. 28,781), at (703) 205-8008.

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